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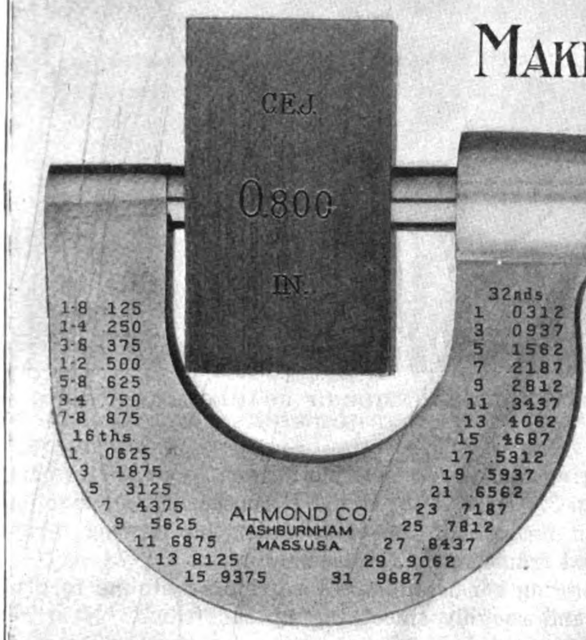

Making The Almond Micrometer

By
Ethan Viall
Editor American Machinist

While we can illustrate some of the mechanical processes through which the parts of a micrometer go, we cannot illustrate the infinite care and workmanship that accompany each step. It requires work to almost the nth degree, in order that cumulative errors may not spoil the final result.

THERE is no more universally used instrument of precision than the micrometer. What was but a few years ago considered to be of use only to the toolmaker is now part of the kit of, or is used by, machine shop workers from the most inexperienced cub to the all-around old timer and expert. The workman of today has been so educated that he thinks and talks in thousandths and ten thousandths of an inch. This has been brought about by his constant use of micrometers.

Naturally in making an instrument of such precision, careful workmanship and a considerable percentage of high-grade workmen must be employed. This means that the skill of the worker is at least as important a factor as the jigs and tools he uses. In other words, the tools and methods described in this article, while good in themselves, would be almost useless unless handled by properly trained mechanics.

The T. R. Almond Manufacturing Co., Ashburnham, Mass., makes both inside and outside micrometers, but only the production of the principal parts for outside micrometers will be touched upon. These micrometers are made regularly in ½- to 24-in. sizes, and have drop-forged frames in the smaller sizes, and screws with buttress threads. A one-inch micrometer is shown in the headpiece, and its component parts in Fig. 1. In this illustration *A* is the screw and spindle, which are made of one solid piece of tool steel. *B* is the frame; *C* the sleeve; *D* the barrel, or thimble; *E* the anvil; *F* the adjusting nut;

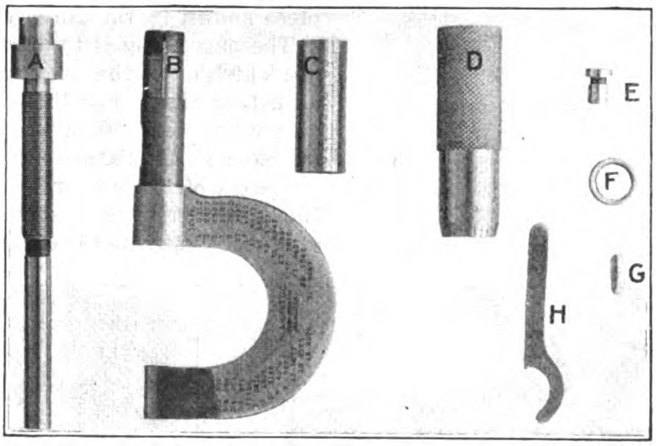

FIG. 1. COMPONENT PARTS OF AN ALMOND MICROMETER

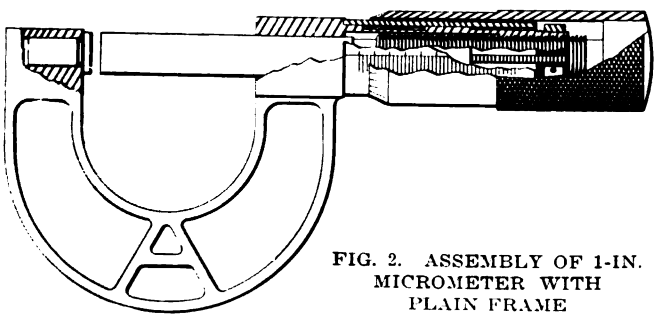

FIG. 2. ASSEMBLY OF 1-IN. MICROMETER WITH PLAIN FRAME

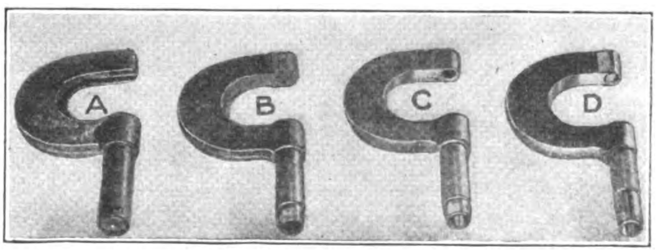

FIG. 3. A FEW STEPS IN FRAME WORK

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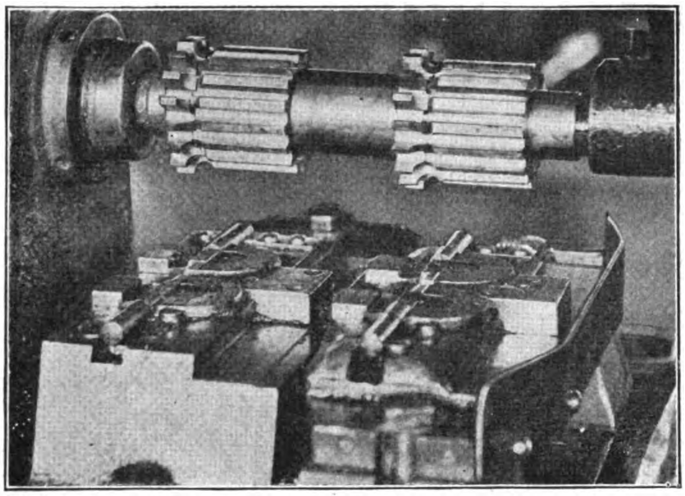

FIG. 4. MILLING SIDES OF FRAMES

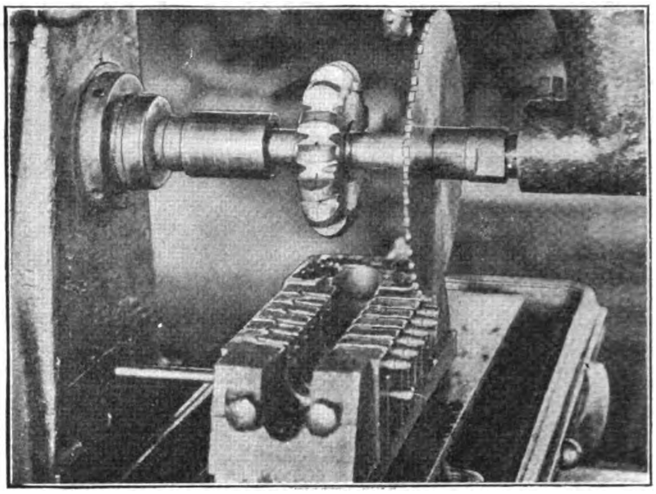

FIG. 5. MILLING INSIDE OF FRAMES AND CUTTING ENDS OF STEMS

G the sleeve tension spring and *H* the adjusting wrench. An assembly drawing of a 1-in. micrometer with plain frame is shown in Fig. 2.

Machining Micrometer Frames

It must be kept in mind that every part of a micrometer must be finished with the greatest care, so that in the final assembly the accumulative result will be satisfactory. On a drop-forged frame, the operations are:

1. Snagging.
2. Milling sides.
3. Milling inside and cutting off end of stem.
4. Drilling, rough-turning, cutting thread.
5. Recessing hole.
6. Reaming hole.
7. Tapping.
8. Splitting.
9. Taking off burrs.
10. Finish turning.
11. Milling recess for tension spring.
12. Drilling anvil hole.
13. Reaming anvil hole.
14. Polishing.
15. Etching.
16. Assembling.

Taking these operations up in turn, we will first refer to Fig. 3. Here *A*, *B*, *C* and *D* represent the principal, though not all, of the steps from the forging to the finished frame ready for assembling.

Snagging consists simply in grinding off the forging flash and roughly smoothing up the frame. Next the frames are placed, four at a time, in the jig shown in Fig. 4, and the sides milled. As both sides have to be milled, two frames are finished at each pass of the formed cutters.

The inside of the frame is milled and the end of the stem is cut off as shown in Fig. 5. The holder is a simple form of clamping jig made up of stationary end pieces and sliding formed jaw-blocks. The frames, six at a time, are placed between these formed blocks and clamped in place by tightening the screws in the end piece shown in the foreground.

The next thing is to drill the spindle hole, rough-turn the outside of the stem and thread the end for the adjusting ring. For this purpose the frame is put into a turret lathe, as shown in Fig. 6. The frame is located in the spindle fixture by means of the milled inside surface which fits over a formed and hardened block on the stationary "jaw" of the holder. A simple formed and screw-operated clamping block keeps the frame in

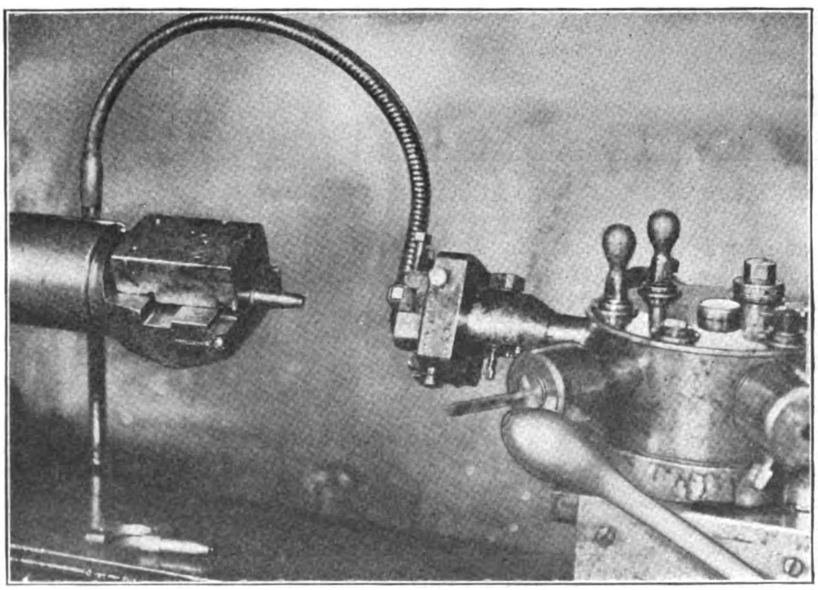

FIG. 6. ROUGHING OUT THE STEMS

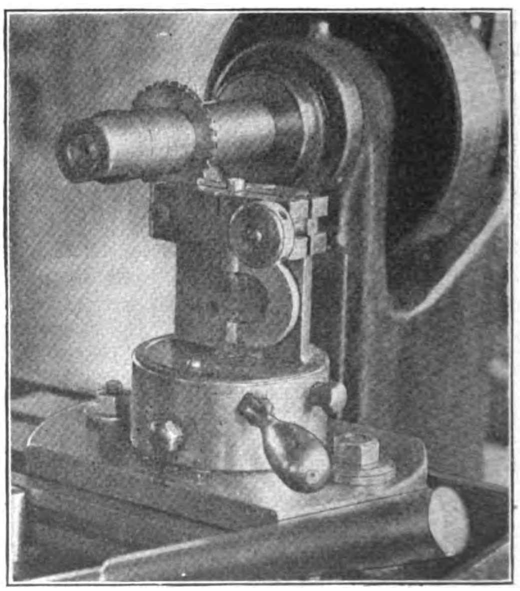

FIG. 7. SLITTING THE END OF A STEM

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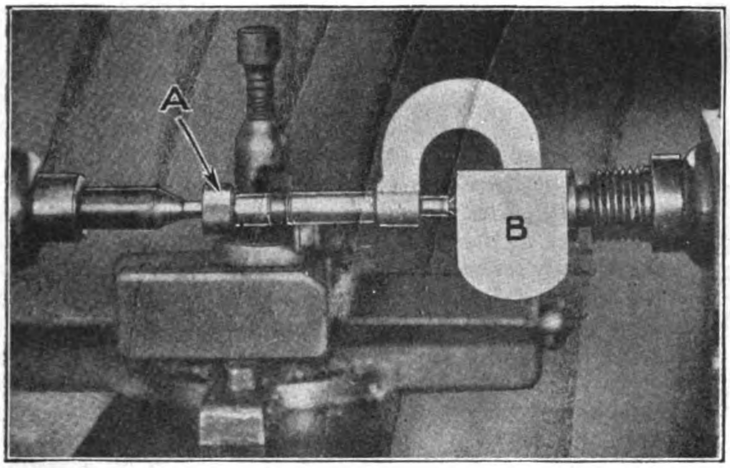

FIG. 8. FINISH TURNING OUTSIDE OF STEM

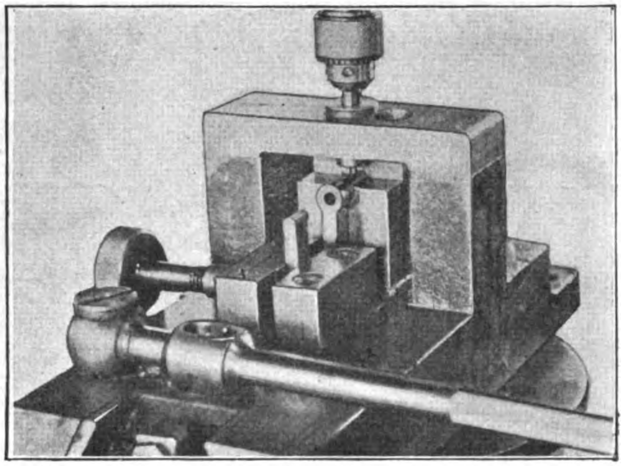

FIG. 9. MILLING RECESS FOR SLEEVE TENSION SPRING

place. The rough-turning is done with a box tool and the threading with a self-opening die head. The hole is next hand-reamed to size and recessed for clearance. Following this the buttress threads for the screw are tapped by hand with a piloted tap.

The tapped end of the stem is split to allow for adjustment, as shown in Fig. 7. The frame is held by the stem in a hinged clamp which is locked by means of a knurled hand nut. Proper height of the work in the jig is secured by means of a hardened screw head on which the frame rests. One cut is made and then the jig is indexed a quarter turn for the other cut. This divides the end into four parts.

Finish Turning Frame

The burrs are removed by hand and then the frame is ready for finish-turning the outside of the stem in a small lathe. For this work the frame is placed on a mandrel. A knurled "draw-in" nut *A*, Fig. 8, pulls the stem to a seat at both ends. The work is driven by the "dog" *B* which has a recess into which the end of the frame fits.

The recess in the stem for the tension spring is milled as indicated in Fig. 9. The frame is located and clamped as shown, and the recess is milled out with an end mill guided by a bushing in the top cross-piece of the jig. After the mill is fed down to the proper depth the length of the slot is secured by movement of the hand lever.

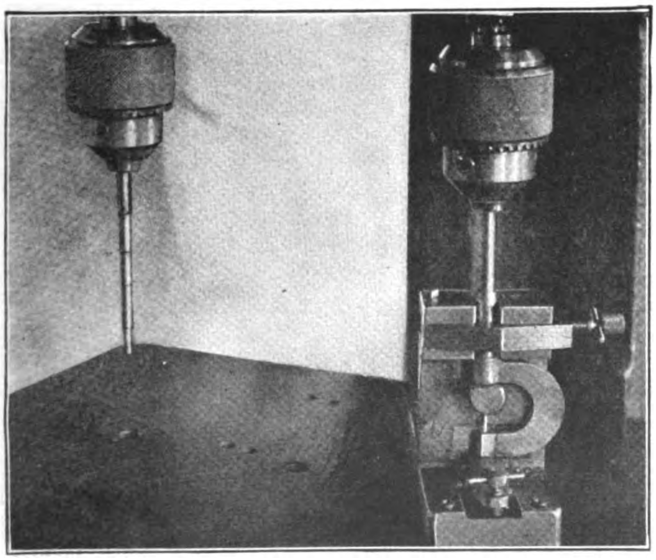

FIG. 10. DRILLING AND REAMING ANVIL HOLE

While listed as separate operations, the drilling and reaming of the anvil hole are done in a two-spindle drilling machine. The frame is held in a jig, as shown at the right in Fig. 10, and the hole is drilled. The jig is next moved over and the hole line reamed with the reamer shown at the left.

The frame is now polished and the figures etched on it. This etching is accomplished by coating the surface of the sides and cutting in the characters on a multiple pantagraph machine, after which acid is used to etch the characters into the metal.

Machining the Spindles

As has been previously mentioned the spindles and screws are made of one solid piece of tool steel.

A spindle is first roughed out from the bar in a screw machine, and the small end centered. The piece is then

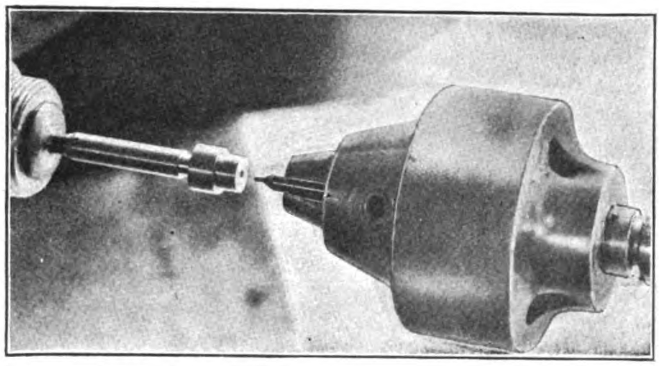

FIG. 11. CENTERING LARGE END OF SPINDLE

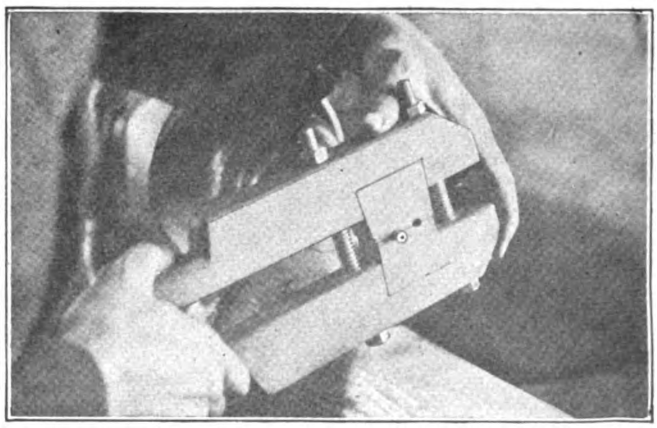

FIG. 12. LAPPING OUTSIDE OF SPINDLE

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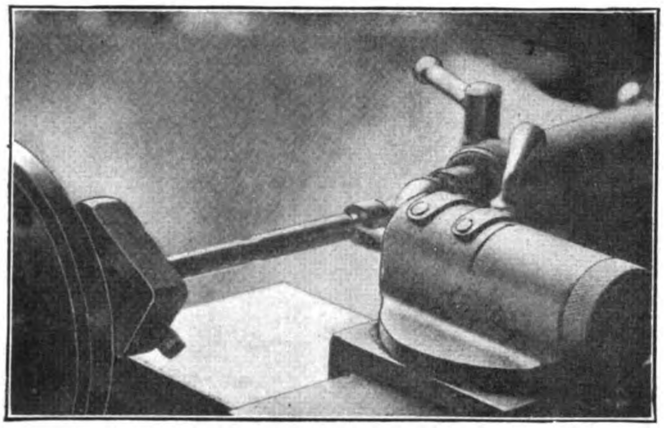

FIG. 13. FINISH-TURNING SPINDLE FOR THREADING

placed in the collet chuck of a small lathe and the large end centered, as shown in Fig. 11.

The small end is next hardened and then the spindle is ground on centers in a grinding machine. Following this it is lapped to size in a small lathe as shown in Fig. 12. The laps are lead blocks, charged with fine abrasive, held in a wooden clamp as shown.

The part of the spindle on which the thread is to be cut is next turned to size in a bench lathe, Fig. 13. The spindle is now ready for turning the thread, which is one of the most particular jobs imaginable.

The Thread Cutting Machine

The thread cutting machine is shown in Fig. 14. The work to be threaded is shown at *A* and the threading tool at *B*. The threading tool has only a cross-feed movement, as the work is fed past it. The lead screw is cut directly on the lathe spindle at *C*, and feeds through the split nut *D* which is set into the bearing or pillow block *E*. The tail spindle *F* is counterweighted and slides in the split bearing *G* as the work is fed forward or back. In putting in or removing the work the tail spindle may be locked out of contact by pushing it back until the latch *H* drops into the notch *I*. The work to be turned is carried on centers and driven by a small dog so adjusted as to eliminate play. The lead screw is of the same lead as the thread cut on the micrometer spindle, which is 40 threads per inch. This lead screw is cut as accurately as it is possible to cut a screw and it took several months to get one uniform enough for the purpose. However, differences of temperature make it necessary to provide some means of compensating for changes in the lead. The same mechanism can, of

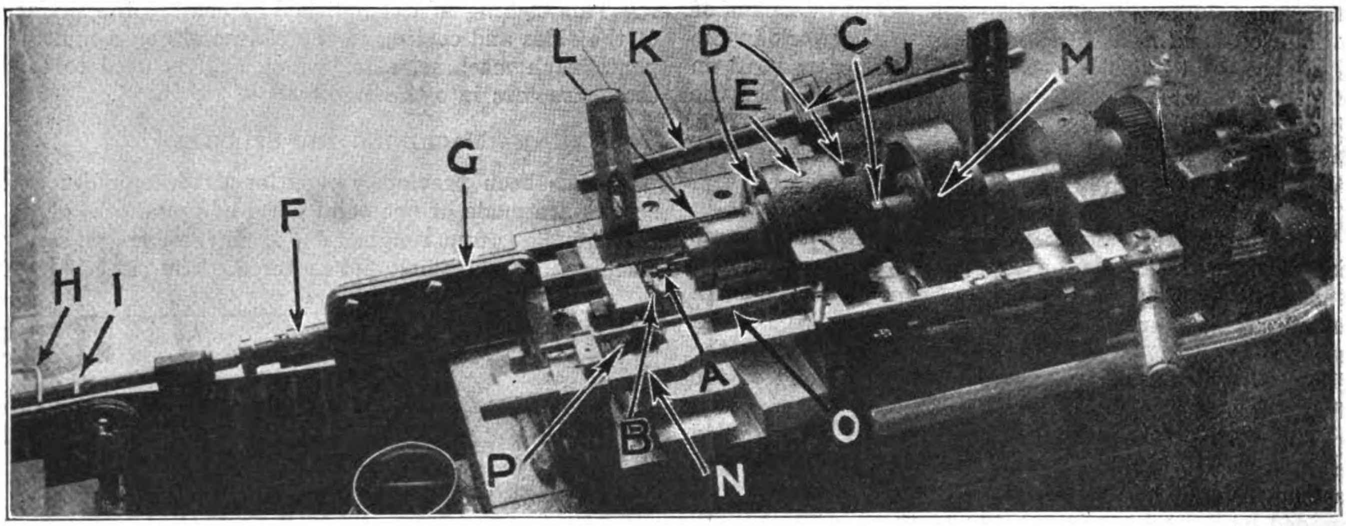

FIG. 14. THE SCREW CUTTING MACHINE

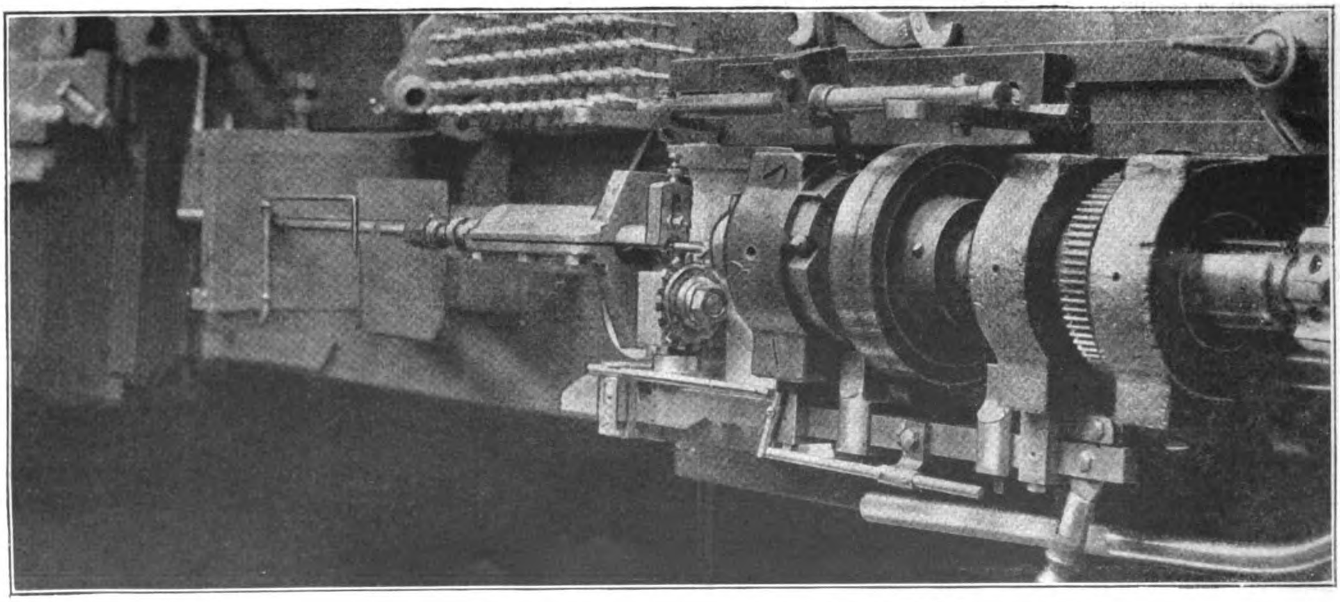

FIG. 15. TOP VIEW OF SCREW CUTTING MACHINE

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course, be used to offset the errors caused by a screw that leads too fast or too slow. The method employed is to mount the lead screw nut in a pillow block, as previously mentioned, in such a way as to eliminate all end play but leave it free to rotate within certain limits. A bar screwed solidly into one flange of the nut connects it to the slide *J* on the bar *K*. It will be seen that the greater the angle at which bar *K* is set, the greater the amount which the nut *D* will be turned as the lathe spindle feeds the work past the threading tool. If the direction of rotation of the nuts is the same as that of the rotation of the lead screw, the lead of the thread cut will be lessened. If the nut is turned in the opposite direction to that in which the lead screw is turning, the lead of the thread being cut will be lengthened. However, as the length of thread cut, and consequently the lengthwise movement of the lathe spindle, is about $1\frac{3}{8}$ in., the distance traversed is not sufficient to give good results. To get around this condition a scheme is resorted to by which the bar *K* is given a movement parallel to the lathe spindle, at approximately three times the speed at which the spindle feeds forward or back. This is done by mounting the bar *K* on a slide having a rack *L* into which the threaded disk *M* meshes. This disk is keyed solidly to the lathe spindle but the thread on it is cut 12 to the inch, in contrast to the 40 to the inch thread on the spindle itself. Hence it will be seen that approximately three times the feed is given the rack *L* and compensating bar *K* as is given to the lathe spindle and work. In consequence, the lead screw nut is given approximately triple the movement it would have if the spindle movement alone was used, with the compensating bar *K* at the same angle. This avoids an excessively steep bar angle.

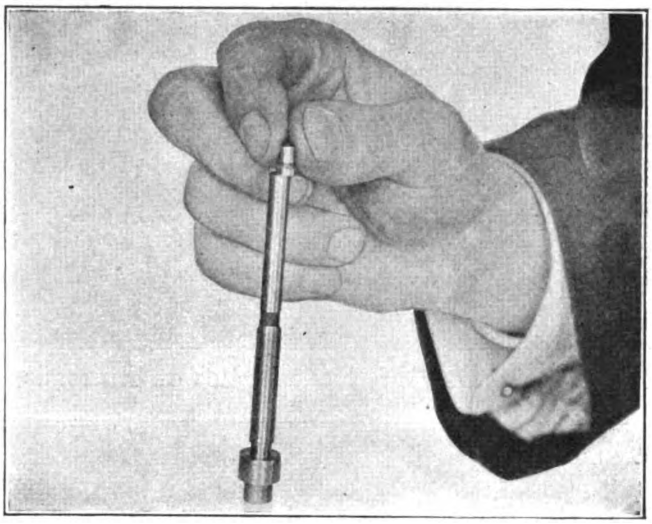

FIG. 20. ANVIL AND SPINDLE END WRUNG TOGETHER

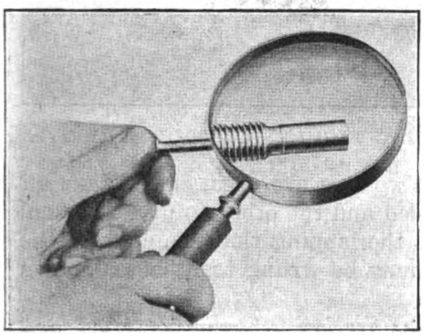

FIG. 16. MAGNIFIED VIEW OF SCREW THREAD

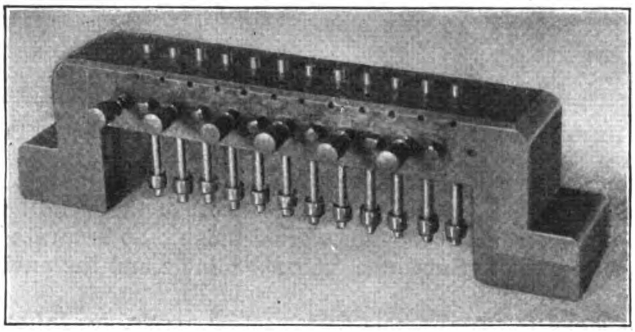

FIG. 17. SPINDLE END GRINDING JIG

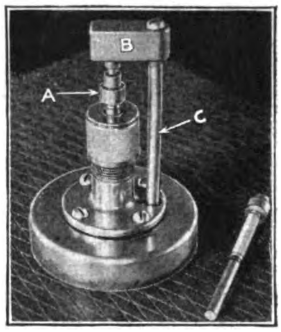

FIG. 18. THE SPINDLE END LAPPING JIG

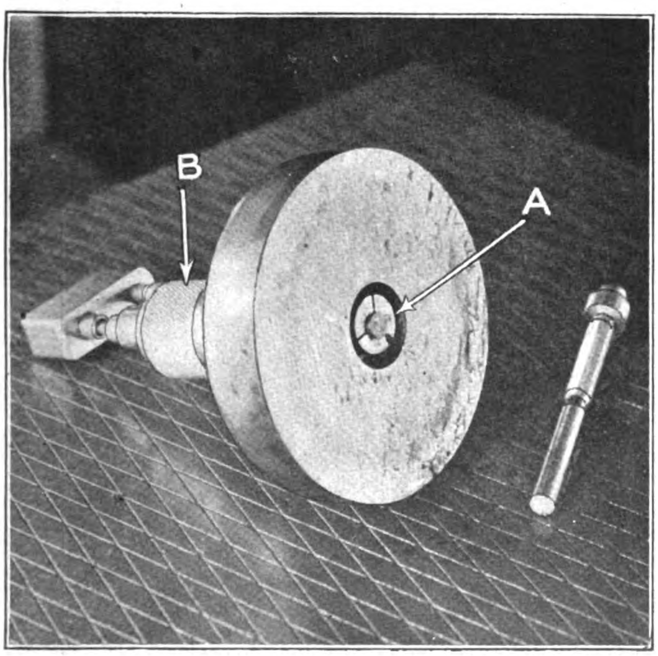

FIG. 19. BOTTOM OF SPINDLE END LAPPING JIG

In cutting threads it has been found that the angle at which compensating bar *K* has to be set varies considerably in hot summer and cold winter. Where temperature changes are sudden, the angle has to be adjusted from day to day, in order to obtain accurate results in the lead of the screw cut.

The thread on the lathe spindle is right hand and so is the thread cut on the micrometer spindle. This makes it necessary to set the threading tool up-side-down, but this has several advantages, one of which is that the chips more readily fall away from the cut.

After the lathe spindle has fed forward with the work on a cut, the bar *N* is automatically forced to the right by means of a stop and allows the tool carriage to slide back and the tool clear the work. The spindle then runs back to the starting point and another stop slides the bar *N* to the left which pushes the tool forward into the cutting position again. The cutting tool is fed forward the right amount for each individual cut by the ratchet action of the small sliding bar *O* which acts on a ratchet wheel *P* on the end of the feed screw.

Some of the mechanism described is more clearly shown in the top view of the same machine given in Fig. 15.

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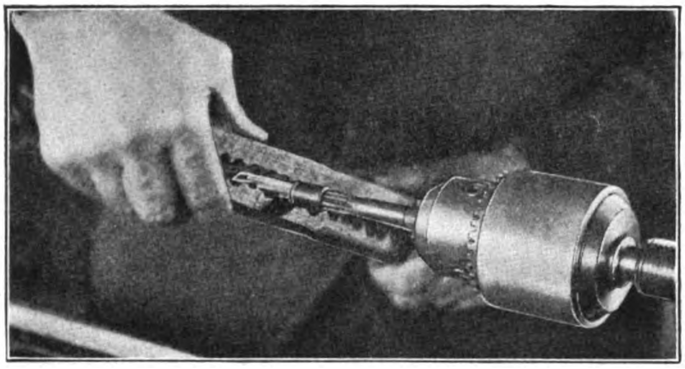

FIG. 21. REAMING OUT THE BARRELS OR THIMBLES

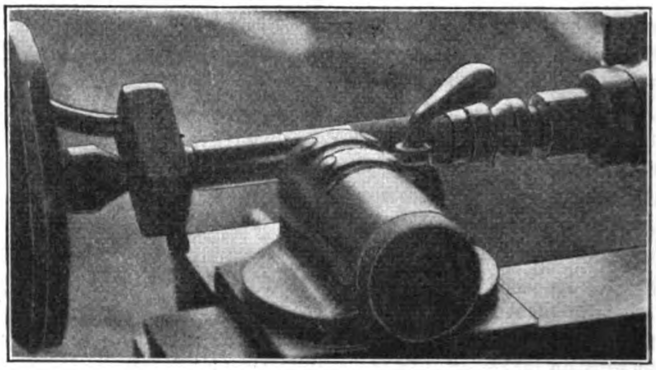

FIG. 22. FINISH-TURNING OUTSIDE OF BARRELS

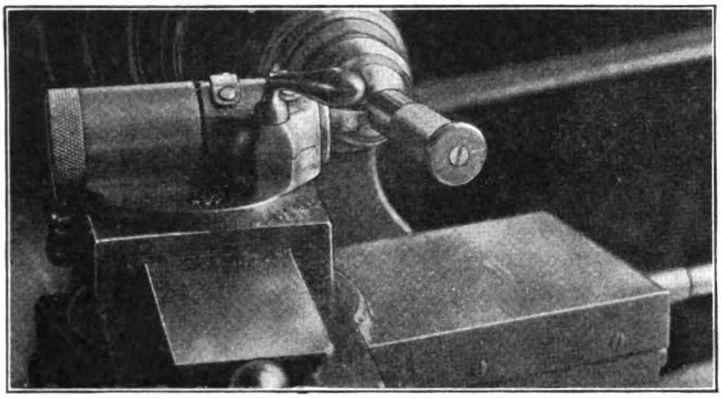

FIG. 23. TURNING BEVEL ON END OF BARREL

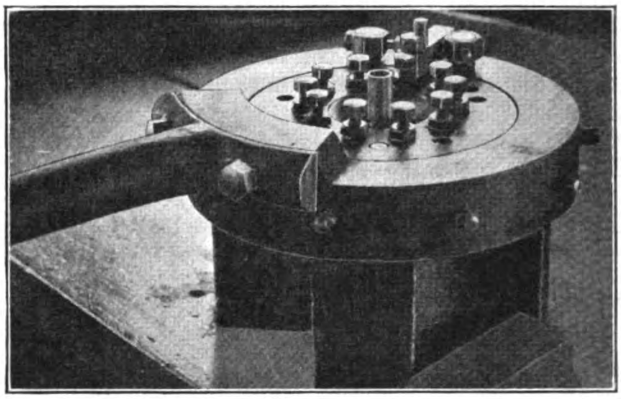

FIG. 24. STAMPING FIGURES ON THE BARREL

The way the thread cut on this machine looks when magnified is indicated in Fig. 16.

The hardened ends of the micrometer spindles are ground on an ordinary surface grinding machine, using the holding jig shown in Fig. 17.

The lapping of the spindle end is a real precision job. The spindle to be lapped is placed in the holder as shown at *A*, Fig. 18. The block *B* on part *C* may be swung around out of the way when putting in or taking out a spindle. The post has a limited amount of vertical spring movement and tends to press the spindle downward when in position.

A view of the bottom of the holder, showing the split collet *A* that grips the end of the spindle, is given in Fig. 19. This collet is tightened by means of the knurled sleeve *B*. In using this holder, the operator rubs it over the diamond-grooved cast-iron lap, rotating it slightly at each stroke in order to wear it evenly. A special gage is used to test the truth of the bottom of the holder from time to time in order to be sure that it is in good shape. Two laps are used, one to take off most of the metal needed and the other to give the final finish. So accurate is the lapping that the ends of the spindle and the anvil may be wrung together as shown in Fig. 20.

Barrels, or thimbles, are drilled, rough-turned and knurled from the bar in a turret lathe, then they are carefully reamed out with an adjustable reamer, as shown in Fig 21. The next step is to place the barrel

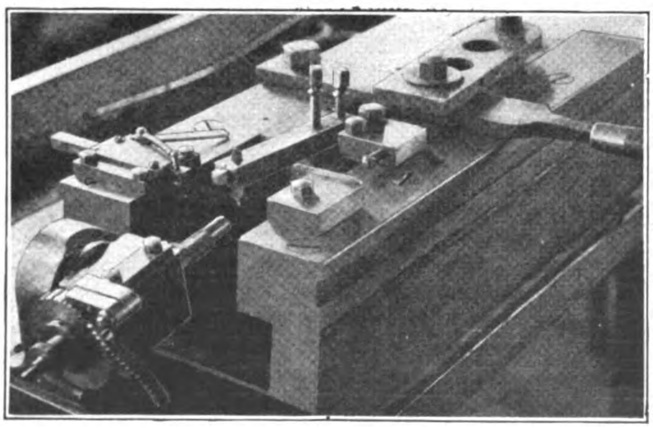

FIG. 25. GRADUATING THE BEVEL ON A BARREL

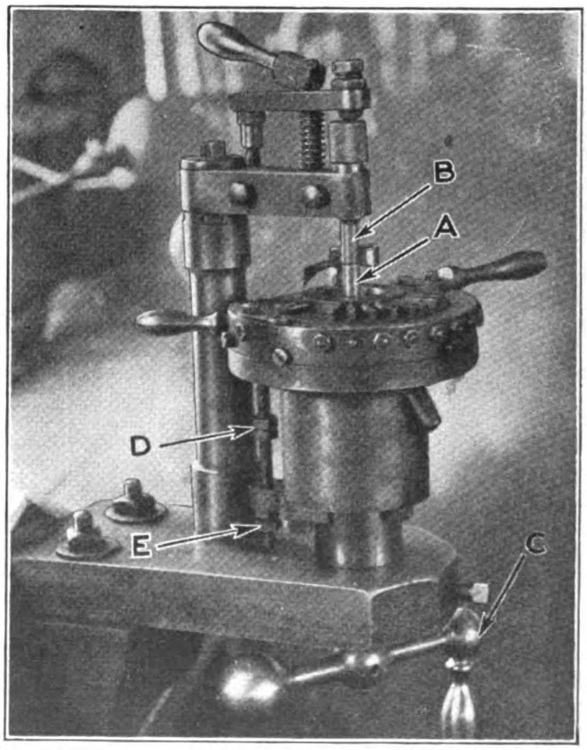

FIG. 26. CUTTING PARALLEL LINES IN A SLEEVE

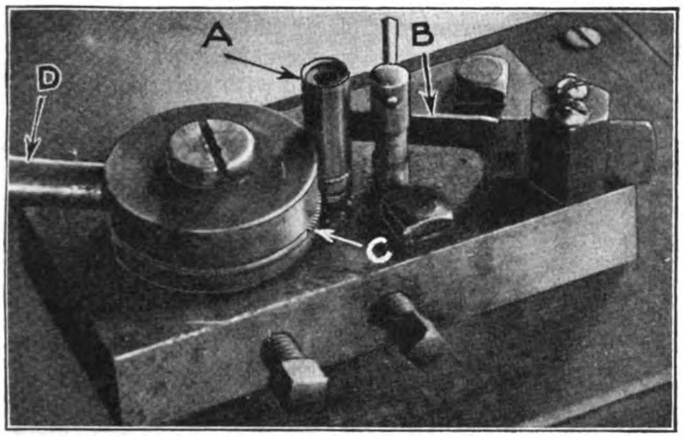

FIG. 27. ROLLING IN FIGURE ON SLEEVES FOR "TEN-THOUSANDTHS" MICROMETERS

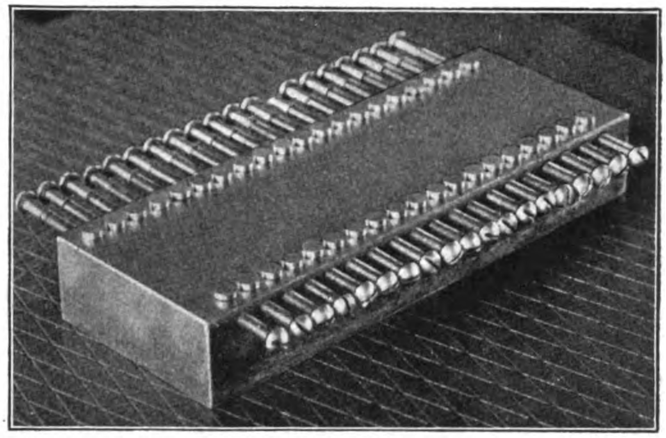

FIG. 28. ANVIL GRINDING AND LAPPING JIG

on a mandrel and finish turn, as shown in Fig. 22. Following this, it is put on a plug mandrel, and the bevel turned as shown in Fig. 23. Next the numbers are stamped in, all at once, in the device illustrated in Fig. 24. In this machine the stamps are arranged radially and are forced inward by means of a cam ring operated by means of the hand lever shown.

The graduations on the end bevel, are cut on the machine, Fig. 25. The indexing is done with the left hand as the operator works the slide lever with his right.

Machining the Sleeves

Sleeves are drilled and rough turned from the bar, and are then reamed in the same way as the barrels. They are then placed on a mandrel and finish turned.

The lines running lengthwise on the sleeves are cut on the machine shown in Fig. 26. One line is cut for micrometers reading in thousandths, and eleven lines for those reading to ten-thousandths of an inch. The single line is cut the full length, but the others, stop far enough from one end to allow for numbering. In the machine, the sleeve is placed over a vertical mandrel at *A* and held in place by means of the eccentric operated hold-down *B*. The carrier for this hold-down may be swung out of the way when desired, by simply releasing the eccentric and pushing the carrier to one side. The tools for cutting the lines are fed into the cutting position by turning the outer cam ring. The whole cutter head is then fed up by turning the handle *C*. Stops at *D* and *E* limit the travel. At the end of the cut the cutters are released by reversing the cam ring, after which the cutter head may be run down and the work removed.

Figures for numbering the lines on the sleeves for the ten-thousandth micrometers are rolled in as shown in Fig. 27. The sleeve is placed over a pin or mandrel at *A* and set in correct position by means of the stop gage *B* which rests in one of the cut lines. The numbers are then rolled in by pulling on lever *D*. Cross lines and the numbers running lengthwise of the sleeves are etched in.

Anvils

Anvils are turned in a screw machine, hardened and then chucked by means of a break-off stub, and cylinder ground. Next they are placed in the jig shown in Fig. 28, and the ends ground in a surface grinding machine. This same jig is then taken to the lapping block and the ends of the anvils all rough and finish lapped at once.

After all the parts of a micrometer have been assembled, the ends of the anvil and spindle are tested for parallelism with Johansson blocks and the screw is tested every tenth of an inch for accuracy with these standard blocks. Where an error in parallelism of the surfaces of the anvil and spindle ends is detected, a special lapping machine is used to eliminate it.

Putting Punch Into "Help Wanted" Ads

By Frank H. Williams

When competition for employees is keen and when the ordinary "Help Wanted" ads in the daily papers fail to bring the desired response, it behooves the plant to put an added punch into its advertising. It is possible to inject a little "jazz" into the Help Wanted ads just as it is possible to liven up and make more interesting and forceful almost any sort of advertising. And, frequently, when a greater punch has been given to the ordinary mere announcement that so many more machinists, etc., are needed, it is found that a single insertion of such an advertisement gets a lot more results than the repeated insertion of a mere every-day announcement.

How Can Ads Be Livened Up?

But how can this added sales-punch be given to the help ads? How can these ads be livened up and made so much more attractive that they will not only attract a lot of attention but also make workmen want to secure employment with the plant that is doing the advertising?

Well, it's a simple proposition—simply examine the matter from the viewpoint of an advertiser. Pick out the big selling point about the job and play up this point in the advertising.

For instance, a Middle Western factory found itself in dire need of additional help in order to turn out the increased quantities of goods it had contracted to make. But the ordinary "Help Wanted" ads in the local daily papers failed entirely of getting all the results desired. The plant superintendent confessed himself up against a stump. He didn't know what to do and finally told the general manager that he'd have to get some help on the proposition. The general manager, in turn, was unable to offer any suggestions and called in the concern's advertising manager to whom the situation was explained.

"Huh," exclaimed the advertising manager, "there's nothing so very difficult about this proposition. This plant has one of the best sales arguments in the city for

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